Space Technology: Investments in our Future

Michael J. Gazarik, Ph.D.
NASA Deputy Chief Technologist
Office of the Chief Technologist

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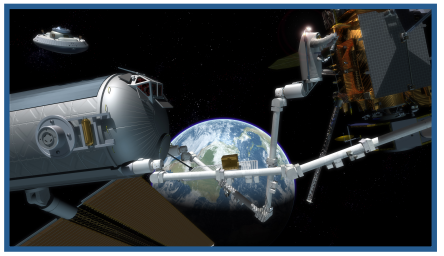
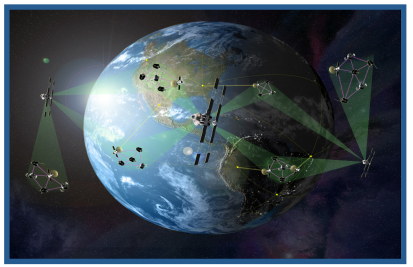
Space Technology: Investments in Our Future

- **Through NASA, America Continues to Dream Big**
  - NASA's future aeronautics, science and exploration missions are grand in scope and bold in stature
- **Enabling Our Future in Space**
  - Investing in high payoff, disruptive technology that industry cannot tackle today, *Space Technology* matures the technology required for NASA's future missions in science and exploration while proving the capabilities and lowering the cost of other government agencies and commercial space activities.
- **NASA at the Cutting Edge**
  - Pushing the boundaries of aeroscience and taking informed-risk, *Space Technology* allows NASA and our Nation to remain at the cutting-edge.
- **Technological leadership is the "Space Race" of the 21st Century**
- **NASA makes a difference in our lives everyday**
  - Knowledge provided by weather and navigational spacecraft
  - Efficiency improvements in both ground and air transportation
  - Solar- and wind-generated energy
  - Cameras found in many of today's cell phones
  - Improved biomedical applications including advanced medical imaging
  - More nutritious infant formula
  - Protective gear that keeps our military, firefighters and police safe

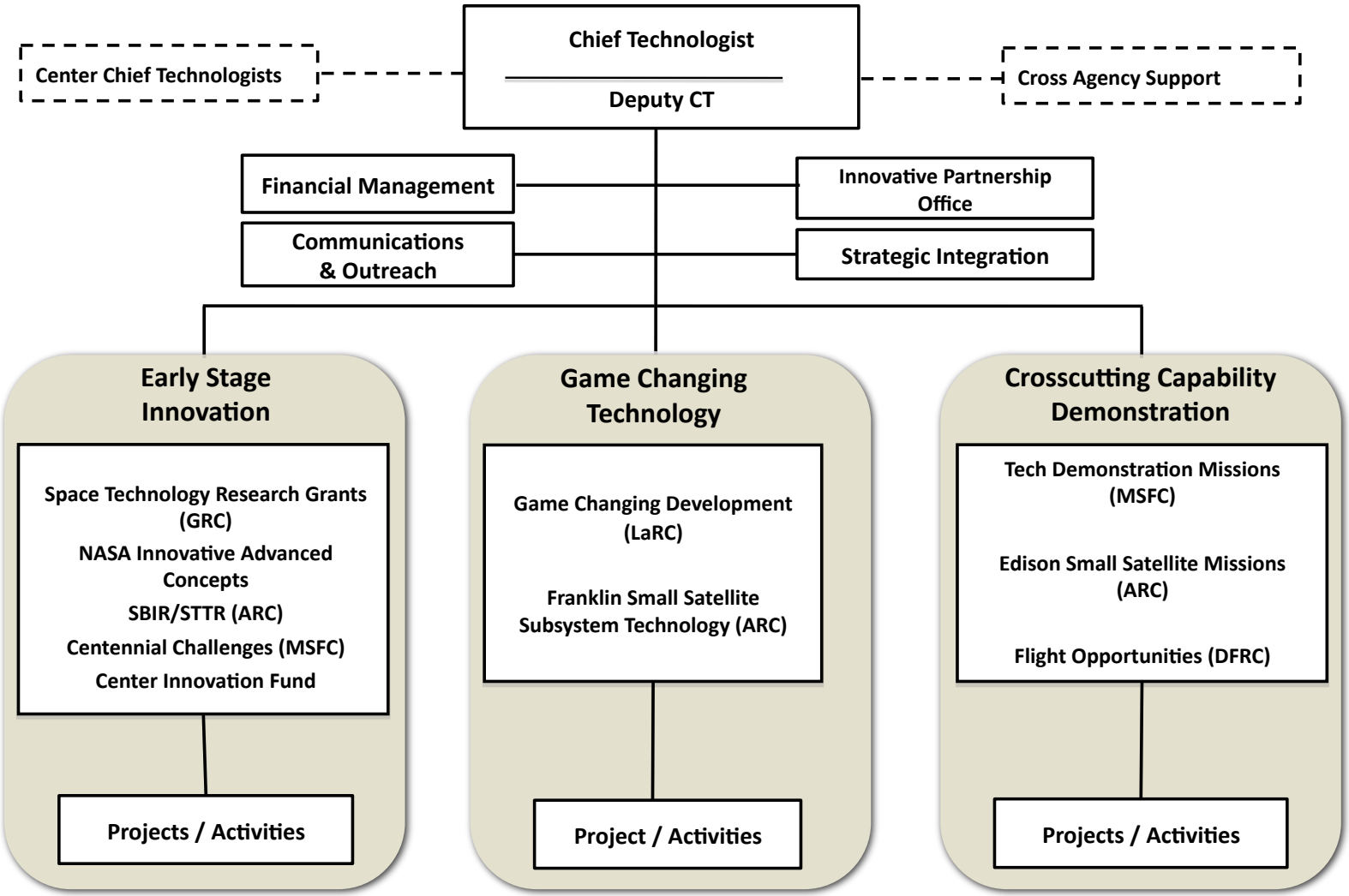




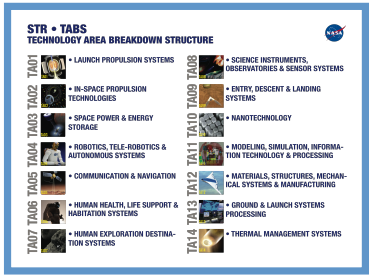
Space Technology

- **Space Technology is a budget line in the FY 2012 request for NASA**
  - Technology development and innovation projects broadly applicable to the Agency's future missions in science and exploration
  - Providing technologies that improve the capabilities and lower the cost of other government agency and commercial space activities
  - Includes Partnerships, Innovation and Emerging Space, Strategic Integration (SI), Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR), Crosscutting Space Technology and Exploration Technology
  - The President's FY 2012 NASA Space Technology budget request is $1,024 million
    - modest increase from the amounts authorized for this suite of programs for FY 2012 in the NASA Authorization Act of 2010, consistent with the Administration's priority on investments in research, technology, and innovation
- **Space Technology builds on the success of NASA's Innovative Partnerships Program (IPP)**
  - In FY 2011, IPP was integrated into Office of the Chief Technologist and the IPP budget integrated into Space Technology
  - In FY 2012, Exploration Technology activities and budget are integrated into Space Technology

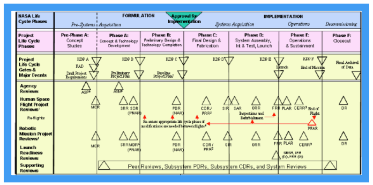
Office of the Chief Technologist Organization



Space Technology: A Focused Approach



- **Strategic Guidance**
  - NASA Strategic Plan
  - Grand challenges
  - Technology roadmaps
- **Full spectrum of technology programs that provide an infusion path to advance innovative ideas from concept to flight**
- **Technical peer-review and competitive selection**
  - Engaging and building an open community of innovators for the Nation
- **Project-focused approach to technology development**
  - Defined start and end dates
  - Project Managers with full authority and responsibility
  - Project focus in selected set of strategically defined capability areas



- **Overarching goal is to reposition NASA on the cutting-edge**
  - Technical rigor
  - Pushing the boundaries
  - Take informed risk and when we fail, fail fast and learn in the process
  - Seek disruptive innovation such that with success the future will no longer be a straight line
  - Foster new capabilities, new approaches, and an emerging commercial space industry

Risk Posture: Necessary to Accomplish Worthy Goals

- **Risk Posture different for technology development**
- **Failure is an Option – in technology-focused development programs**
  - "Failing Forward" because a technology did not pan out results in increased knowledge and learning
  - How "failure" is treated is key to the success of the Program

- **Programs focused on technology development afford us the opportunity to take technical risk. Accomplishing something great demands that we do.**

"Risk intolerance is a guarantee of failure to accomplish anything of significance." – Sandia National Laboratories, *Risk, Challenge and Reward in LDRD*

- **Informed Risk-Taking**
  - **Practice of understanding the risk one is taking in implementing a project and managing project resources to best mitigate the integrated risk posture.**

"We cannot shrink from risk.... When you take chances and do stuff that nobody else has ever done…We have to be willing to accept risk. We have to be willing to do daring things." - Charlie Bolden

Broad Technology Maturation Coverage

- Space Technology Research Grants

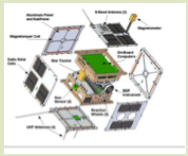
- NASA Innovative Advanced Concepts (NIAC)

- Center Innovation Fund

- Centennial Challenges Prize

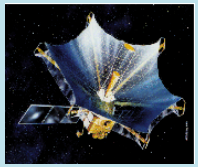
- Small Business Innovation Research & Small Business Technology Transfer (SBIR/STTR)

- Game Changing Development

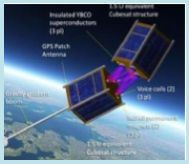


- Franklin Small Satellite Subsystem Technology

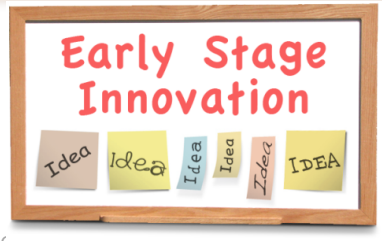
- Flight Opportunities



- Technology Demonstration Missions



- Edison Small Satellite Demonstration Missions



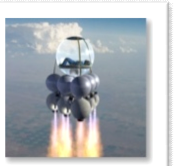
Space Technology Grand Challenges

Important space-related problems that must be solved to efficiently and economically achieve our missions

Space Technology Grand Challenges & Space Technology Roadmaps will prioritize technology portfolio

Space Technology Grand Challenges

Expand Human Presence in Space



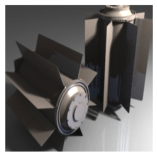
Economical Space Access

Space Health and Medicine

Telepresence in Space

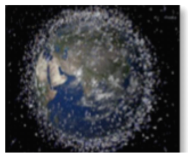
Space Colonization

Manage In-Space Resources

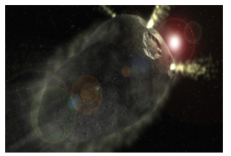


Affordable Abundant Power

Space Way Station

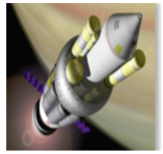


Space Debris Hazard Mitigation

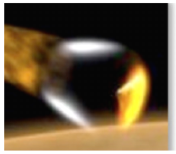


Near-Earth Object Detection and Mitigation

Enable Transformational Space Exploration and Scientific Discovery

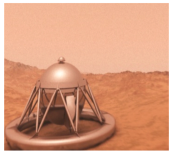


Efficient In-Space Transportation

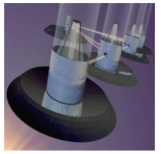


High-Mass Planetary Surface Access

All Access Mobility



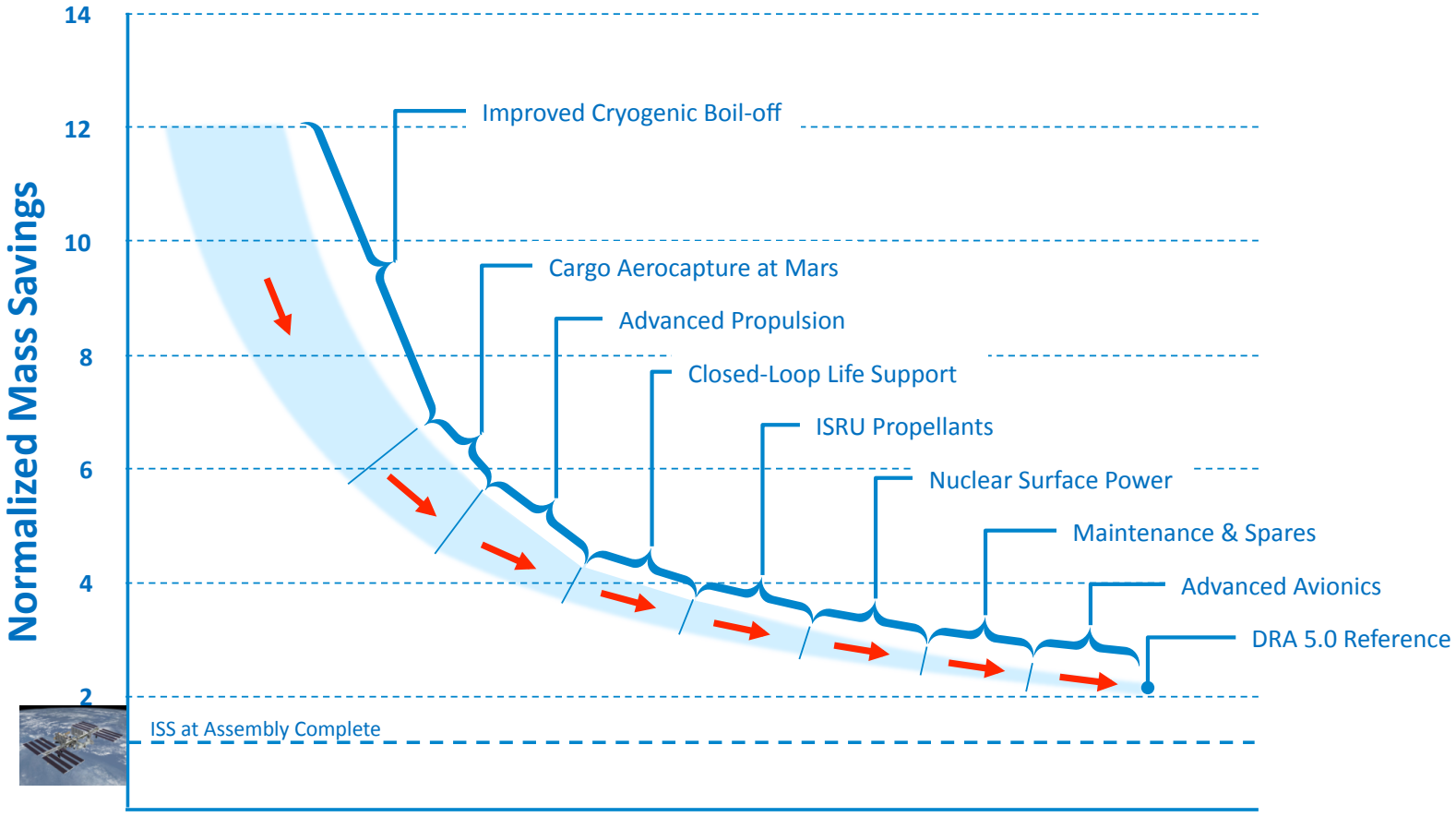
Surviving Extreme Space Environments



New Tools of Discovery

More Information at http://www.nasa.gov/offices/oct/strategic_integration/grand_challenges_detail.html

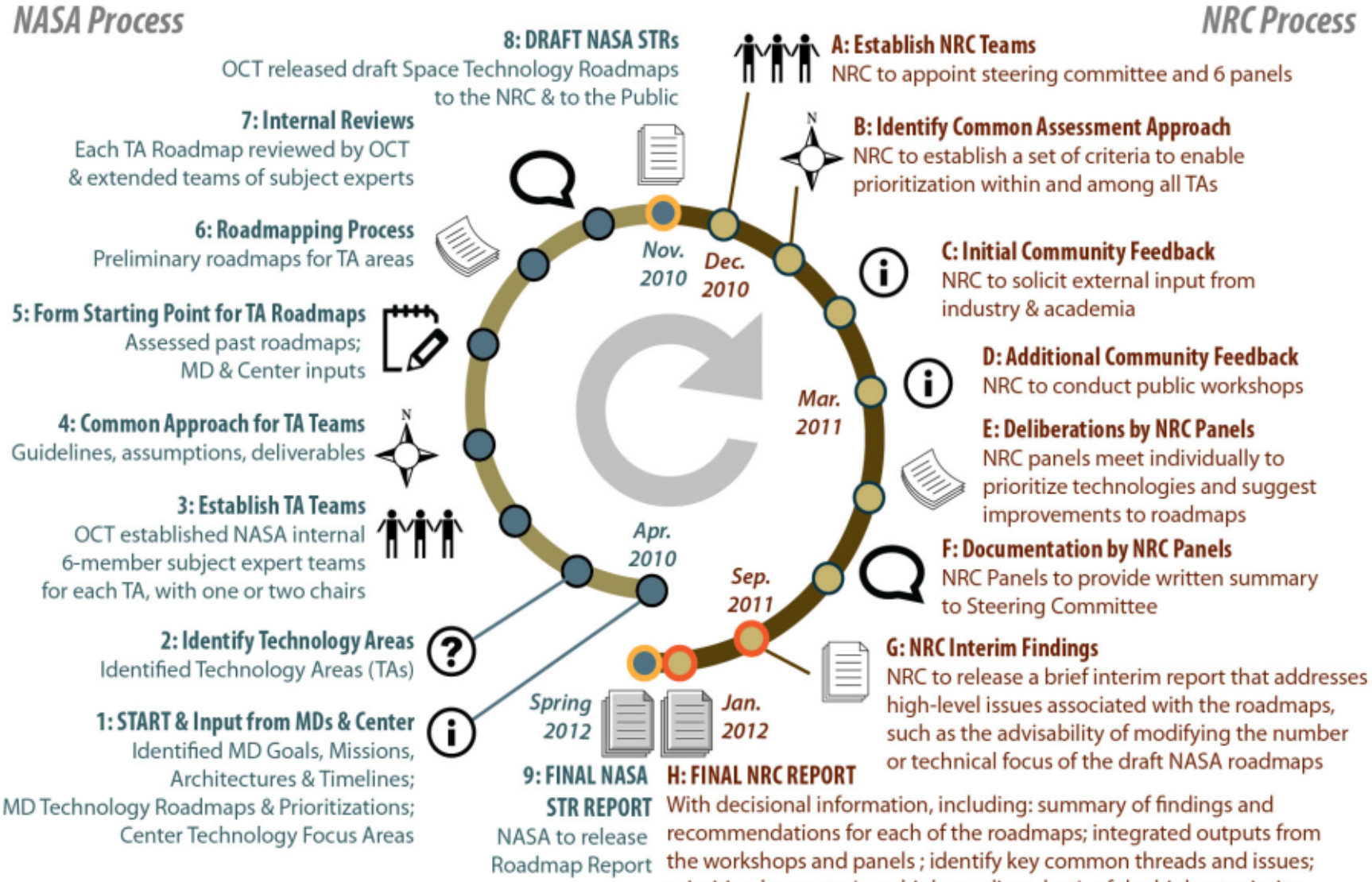
The Value of Technology Investments
Mars Mission Example*



- Without technology investments, the mass required to initiate a human Mars mission in LEO is approximately twelve times the mass of the International Space Station
- Technology investments of the type proposed in the FY 2012 budget are required to put such a mission within reach

* The ordering and impact of these technologies are an example valid for one particular architecture and is not intended as an architecture endorsement nor technology development prioritization

Space Technology Roadmap Process



Technical Area Breakdown Structure

TA01 

• LAUNCH PROPULSION SYSTEMS

TA02 

• IN-SPACE PROPULSION TECHNOLOGIES

TA03 

• SPACE POWER & ENERGY STORAGE

TA04 

• ROBOTICS, TELE-ROBOTICS & AUTONOMOUS SYSTEMS

TA05 

• COMMUNICATION & NAVIGATION

TA06 

• HUMAN HEALTH, LIFE SUPPORT & HABITATION SYSTEMS

TA07 

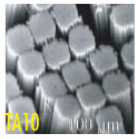
• HUMAN EXPLORATION DESTINATION SYSTEMS

TA08 

• SCIENCE INSTRUMENTS, OBSERVATORIES & SENSOR SYSTEMS

TA09 

• ENTRY, DESCENT & LANDING SYSTEMS

TA10 

• NANOTECHNOLOGY

TA11 

• MODELING, SIMULATION, INFORMATION TECHNOLOGY & PROCESSING

TA12 

• MATERIALS, STRUCTURES, MECHANICAL SYSTEMS & MANUFACTURING

TA13 

• GROUND & LAUNCH SYSTEMS PROCESSING

TA14 

• THERMAL MANAGEMENT SYSTEMS

Investments in Technology

OCT Technology Investments

STR • TABS
TECHNOLOGY AREA BREAKDOWN STRUCTURE

- TA01 • LAUNCH PROPULSION SYSTEMS
- TA02 • IN-SPACE PROPULSION TECHNOLOGIES
- TA03 • SPACE POWER & ENERGY STORAGE
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- TA06 • HUMAN HEALTH, LIFE SUPPORT & HABITATION SYSTEMS
- TA07 • HUMAN EXPLORATION DESTINATION SYSTEMS
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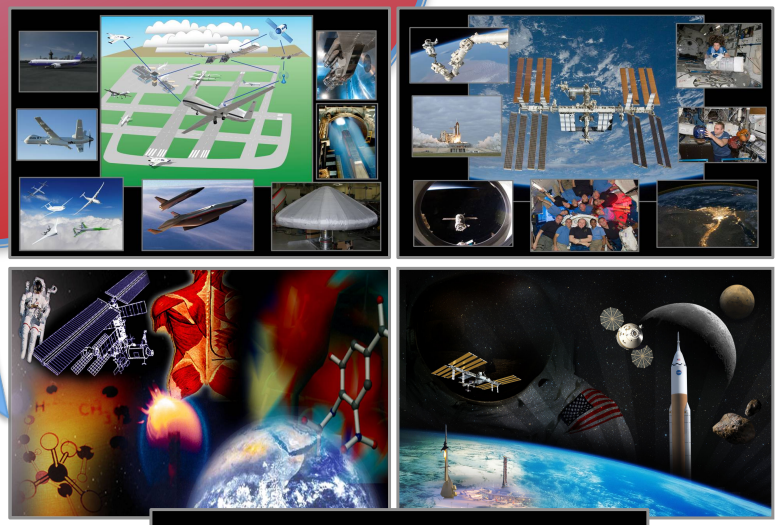


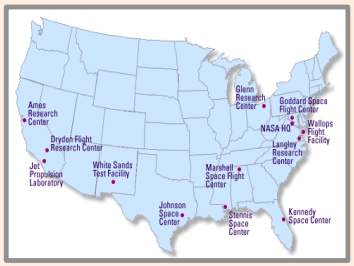
NASA Mission Directorates

FY12 Space Technology Project Areas

Early Stage Innovation

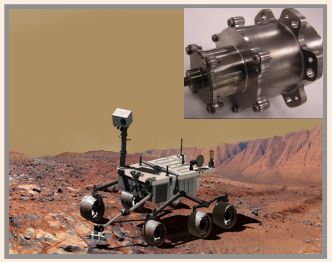
Space Technology Research Grant Program

NASA Innovative Advanced Concepts (NIAC) Program



Center Innovation Fund Program

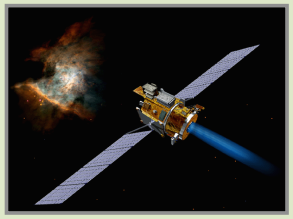
Centennial Challenges Prize Program



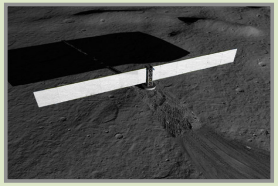
Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) Program

FY12 Space Technology Project Areas

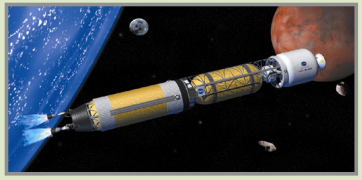
Game Changing Technology



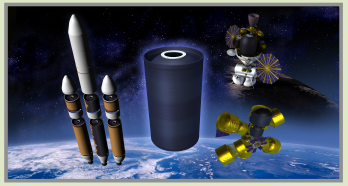
In-Space Propulsion



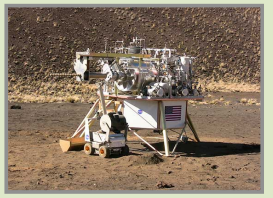
Space Power Generation



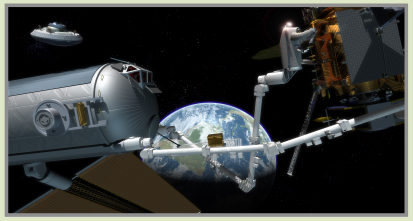
Nuclear Systems



Lightweight Materials and Structures



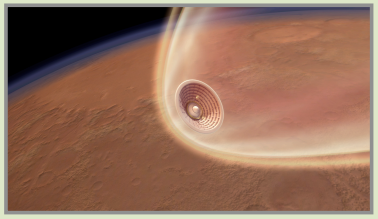
In-Situ Resource Utilization



Autonomous Systems

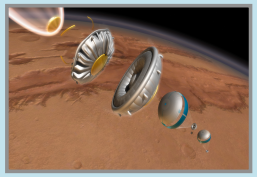
Human-Robotic Systems

Next Generation Life Support

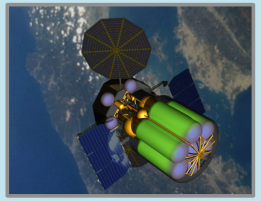


Hypersonic Inflatable Aerodynamic Decelerator

Crosscutting Capabilities



Supersonic Inflatable Aerodynamic Decelerator

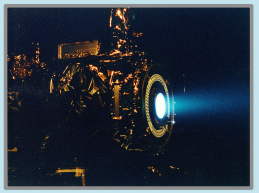


Cryogenic Propellant Storage & Transfer

Human Exploration Tele-robotics

Autonomous Landing & Hazard Avoidance Technology (ALHAT)

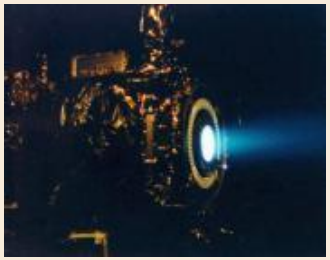
MSL Entry Descent and Landing Instrument (MEDLI)



Solar Electric Propulsion

Technology Demonstration Mission: Solar Electric Propulsion (SEP)

A STATUS QUO



- Low thrust Ion prop operational
- Med Hall EP thrusters ground tested at vacuum – TRL 5
- Solar power generation is readily available up to 100 kW (ISS)
- Need space EP demo at > 25 kW

B NEW INSIGHT

Technology Demo to Test

- High Power EP using multiple ~10kW thrusters w/ > 25 kW tot.
- High Voltage, High Power Solar Array w/ stable power mgmt.
- Long duration (> 6 mo) sustained high thrust (>25 kW)

MAIN ACHIEVEMENT:

• Demo high power (> 25 kW), high η (> 50%), med ISP (> 1000s), long duration (> 6 mo), reliable EP

• Couple high power solar array and power mgmt w/ hall EP to prove deep space exploration capability

HOW IT WORKS:

• 30 kW Array

• High power hall propulsion system

• 15 – 20 mt LEO launch vehicle

ASSUMPTIONS & LIMITATIONS

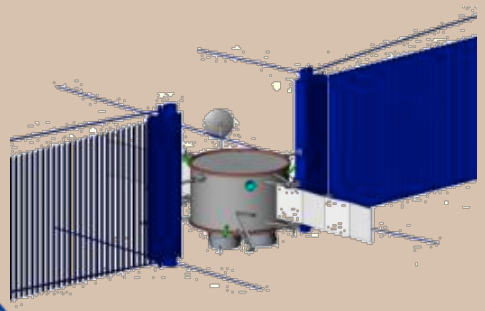
• SEP demo to use TRL 6 panels, and TRL 4-5 hall thrusters & power management system

• Human exploration systems will need 300 kW (~ 5 N) class system

APPROACH:

• Pursuing potential partnership with another government agency

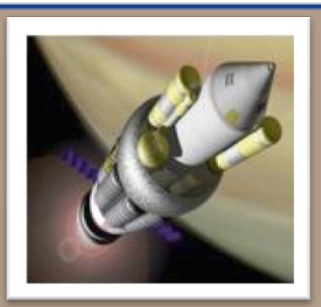
C



D QUANTITATIVE IMPACT

- Dramatically expand capability of future space exploration by demonstrating med (ISP > 1000s) and med thrust (~ 1 N)
- Enable future human exploration missions to NEOs, Mars and other deeps space destinations with shorter duration trip times and much lower earth departure mass requirements
- May enable follow-on NEP propulsion

E END-OF-PHASE GOAL



Efficient In-space Transportation

- Develop systems that provide rapid, efficient and affordable transportation to, from and around space destinations.

Demonstrating efficient in-space transportation with a high power solar electric propulsion system

Hypersonic Inflatable Aerodynamic Decelerator (HIAD)

A

STATUS QUO

- Landed mass on Mars currently limited to < 2 mt, while future human missions require > 20 mt
- Deployable or inflatable entry systems are at TRL 2 – 5
- Flexible ablative TPS at TRL 2-3

B

NEW INSIGHT

- Flight demo of HIAD systems is needed to gain tech infusion
- New mechanical deployable entry systems concepts are promising
- Flexible variants of previous rigid ablative TPS is changing the game

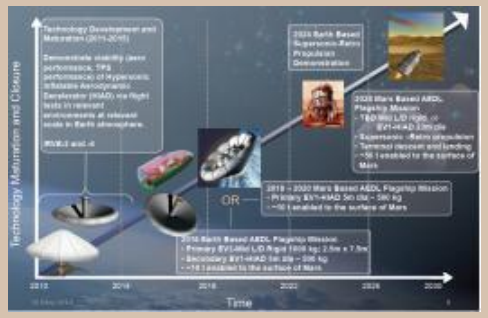
MAIN ACHIEVEMENT:

- Demonstrate an inflatable earth entry system
- Raise to TRL 5 a deployable lifting and low ballistic coef entry system
- Raise to TRL 5 flexible ablative TPS

HOW IT WORKS:

- Flexible or compliant ablative TPS is an enabler for deployable or inflatable entry systems
- Inflatable or deployable entry systems significantly reduce ballistic coefficient & entry system perf w/o exceeding shroud limits
- Material testing and flight demos of all components & systems needed

C



D

QUANTITATIVE IMPACT

- Large entry systems with low ballistic coefficients capable of landing > 20 mt are essential for human missions to Mars
- Flexible ablative TPS is enabling

E

END-OF-PHASE GOAL

High-Mass Planetary Surface Access

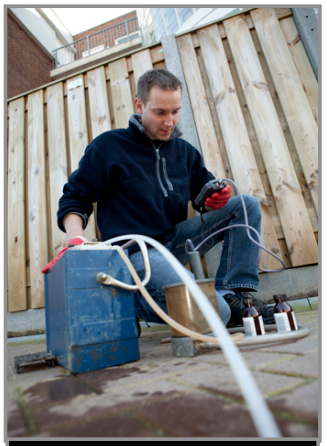
- Develop entry, descent and landing systems with the ability to deliver large-mass, human and robotic systems, to planetary surfaces

For high –mass planetary surface access new decelerator materials and systems need to be developed

NASA Space Technology Improving Our Lives

Advanced Diagnostic Ultrasound in Microgravity

LED Light Therapy For Pain Management



Groundwater Remediation

Clean Energy

Winglets Save Fuel Cost

Lithium Batteries for Cars

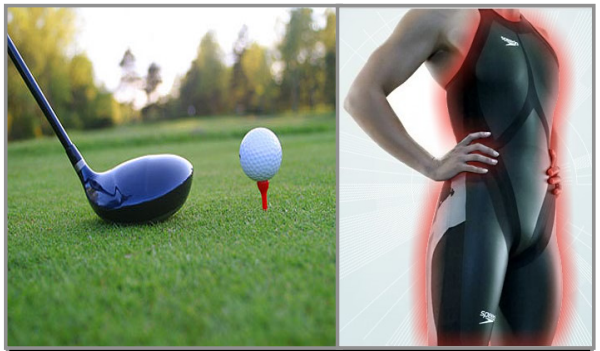
Aerogel Insulation

Eye Exams

Infrared Thermometers

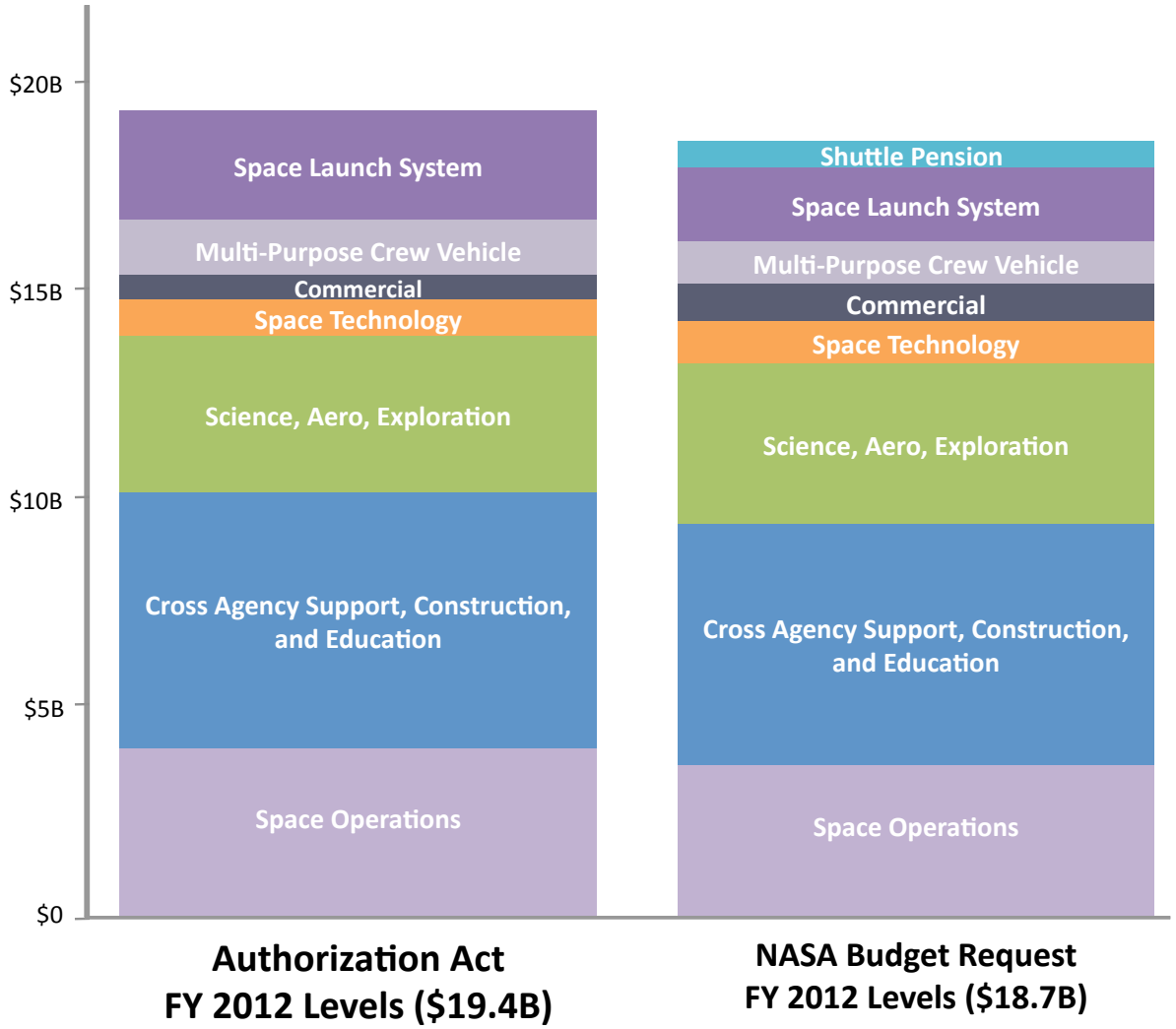
Memory Foam

Nutritional Supplements



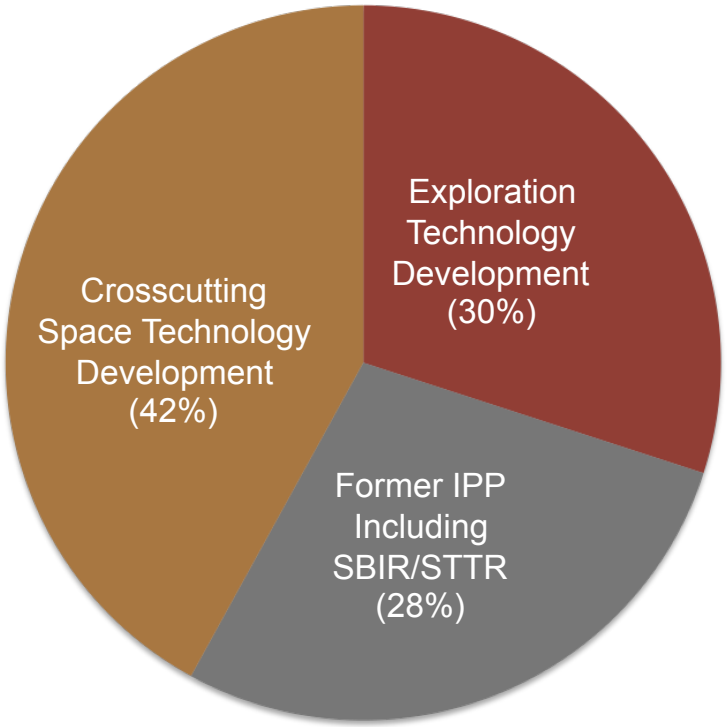
Sports and Recreation

NASA Budget Challenges



Proposed FY 2012 Space Technology Budget

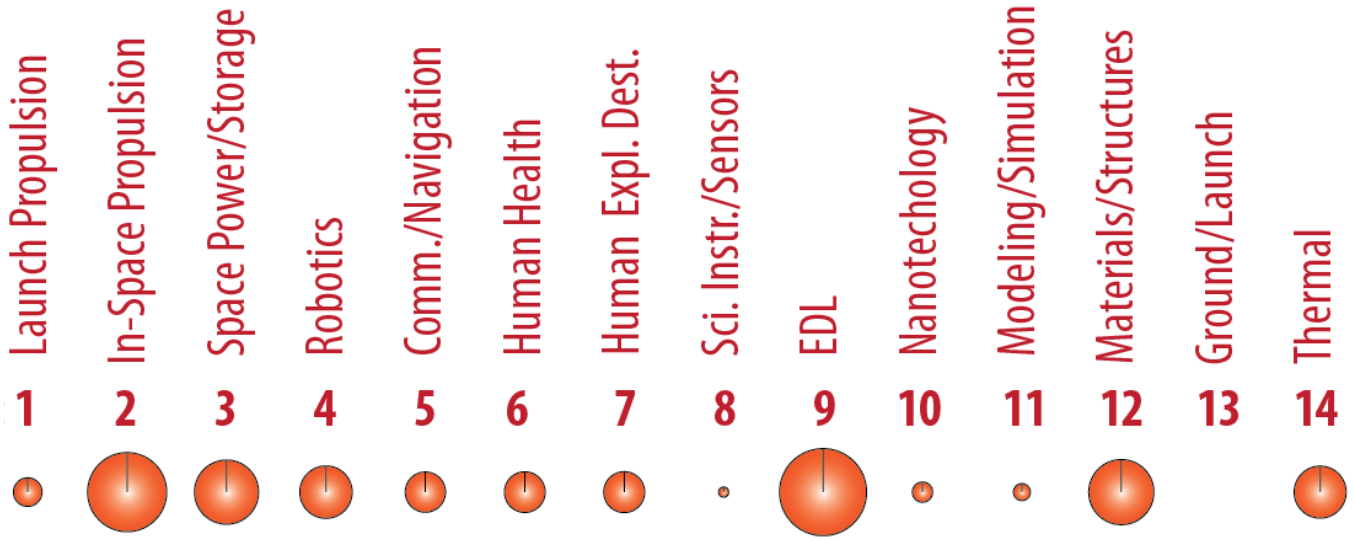
- In FY 2012, Space Technology is proposed at approx. 5% of the President's $18.7B request for NASA.
- The $1024M for Space Technology in FY 2012 includes:
  - The SBIR/STTR program and related technology transfer and commercialization activities ($284 million) funded in FY 2010 through NASA's Innovative Partnership Program
  - Movement of a majority of the Exploration Technology Development and Demonstration activities ($310 million) from the Exploration Systems Mission Directorate
  - The Crosscutting technology development activities ($430 million) proposed as part of the President's FY 2011 request.
- Carefully formulated over the past year, and have deep roots in technology development approaches NASA has pursued in previous years.
- The FY 2012 request for Space Technology provides a modest increase above the level projected in the NASA Authorization Act of 2010
  - consistent with the Administration's priority on federal investments in research, technology and innovation across the Nation



NASA FY2012 Proposed Space Technology Budget ($1024M)

Technical Area Portfolio in FY12

Guided 335M



Over 300M remains reserved for future solicitations

Opportunities

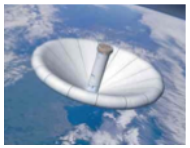
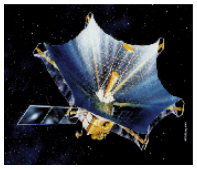
- SBIR/STTR, Flight Opportunities, Center Innovation Fund, Centennial Challenges are ongoing programs
  - funded in FY 2011 CR based on enacted FY 2010 levels.
- Inaugural **Space Technology Graduate Fellowship**
  - Closed February 23, selections anticipated for start of Fall 2011 semester
- Released March 1, 2011
  - **NASA Innovative Advanced Concepts** (NIAC) seeks transformative ideas to enable new aeronautics and space systems capabilities.
  - **Game Changing Development** is soliciting proposals for research and technology development for revolutionary improvements in America's space capabilities.
  - **Technology Demonstration Mission** proposals are sought in four areas:
    - high-bandwidth deep space communication, navigation and timing
    - orbital debris mitigation or removal systems
    - advanced in-space propulsion systems
    - autonomous rendezvous, docking, close proximity operations and formation flying

http://www.nasa.gov/offices/oct/home/solicitations.html







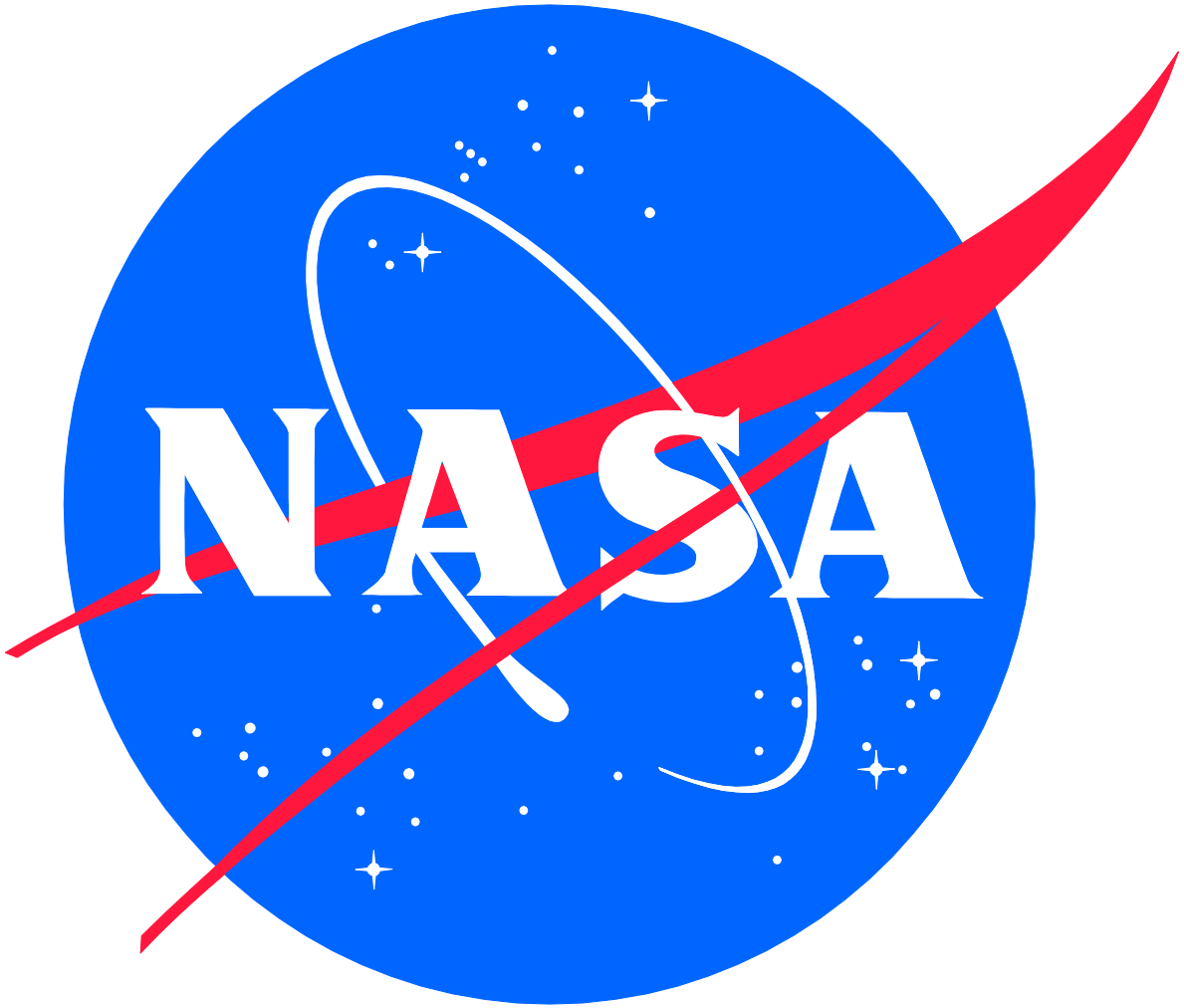
NASA Space Technology: Part of a Broader National Strategy

- **Space Technology is the central NASA contribution to a revitalized research, technology and innovation agenda for the Nation.**
  - A renewed technology emphasis balances NASA's long-standing core competencies of research and technology, spaceflight hardware development, and mission operations.
  - By investing in high payoff, disruptive technology that industry cannot tackle today, Space Technology matures the technology required for NASA's future missions in science and exploration while proving the capabilities and lowering the cost of other government agencies and commercial space activities.

- **Pushing the boundaries of aeroscience and taking informed-risk, Space Technology allows NASA and our Nation will remain at the cutting-edge.**

- **In addition to providing a more vital and productive aerospace future, by investing in Space Technology, NASA will continue to make a difference in our lives everyday.**

President Obama, February 3, 2011, at Penn State: "*Innovation is what this country is all about. Sparking the imagination and creativity of our people, unleashing new discoveries -- that's what America does better than any other country on Earth. That's what we do. We need you to seek breakthroughs and new technologies that we can't even imagine yet.*"



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